(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 May 2001 (10.05.2001)

PCT

(10) International Publication Number
WO 01/33569 A1

(51) International Patent Classification[7]: G11B 20/10, 20/00, G10H 1/36, 1/00

(21) International Application Number: PCT/US00/28847

(22) International Filing Date: 19 October 2000 (19.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/431,897 2 November 1999 (02.11.1999) US

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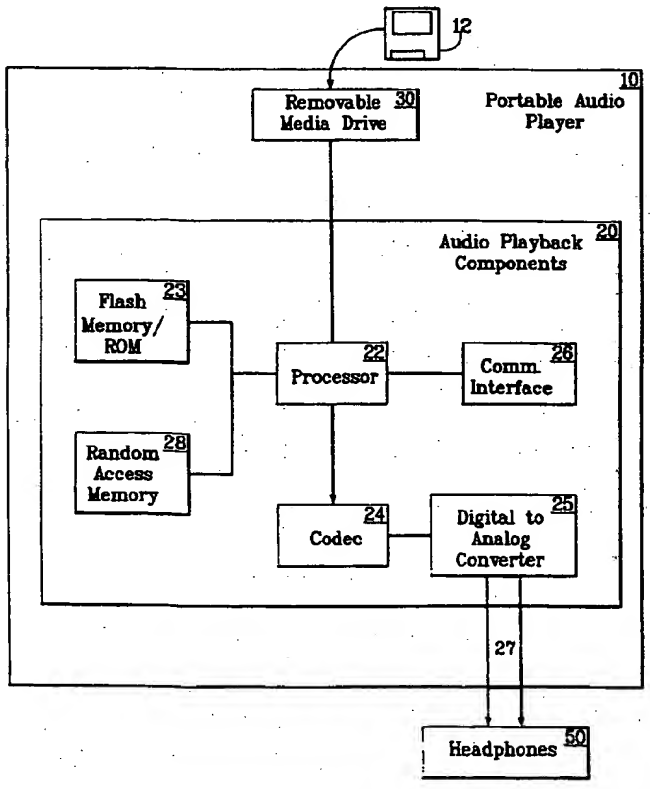
(81) Designated States *(national)*: AU, BR, CA, CN, JP, KR, MX, SG.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

[Continued on next page]

(54) Title: PORTABLE AUDIO PLAYBACK DEVICE AND REMOVABLE DISK DRIVE



(57) Abstract: A portable audio player (10) that includes a removable media drive (30) and audio playback components (20) to play audio data stored on the removable media (12). The audio playback components (20) include an audio decoder, an audio Codec (24), and a digital to analog converter (25) which receives outputs analog audio signals to headphones (50). A memory (23) within the audio player (10) stores an operating system and a plurality of software Codecs. A suitable software Codec is selected from the plurality of Codecs to decompress the audio data file prior to conversion to analog signals. If the suitable Codec is not stored in memory, it may be read from the removable media (12) such that the portable audio player (10) may properly play the audio content. The portable audio player (10) may also be operated as a removable data storage device for a personal computer.

WO 01/33569 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

PORTABLE AUDIO PLAYBACK DEVICE AND REMOVABLE DISK DRIVE

FIELD OF THE INVENTION

The present invention relates to portable media players. In particular, the present invention relates to a portable audio playback device that plays digital audio files stored on removable media in a file system format used in computing devices.

BACKGROUND OF THE INVENTION

Portable audio devices, such as cassette tape players and compact disk (CD) players are well known. Such portable audio players are typically battery powered and allow a listener to listen to tapes and CDs via headphones connected to the player. Portable audio devices have become more popular due to their long battery life and compact size. While portable audio devices allow listeners to take their music with them and have become a driving force behind the growth of the music industry, these devices are limited because they have failed to keep pace with newly emerging audio distribution channels.

In particular, with the advent of the Internet, audio and video content is routinely downloaded from vendors' Web Site or from the artists themselves directly to the listener's personal computer or other device. Further, several audio formats, such as MPEG Audio Layer-3 (MP3), Liquid Audio, Real Audio, etc. are commonly used to compress the audio content for distribution. Conventional audio players not capable of directly playing such content, as they are not capable of decompressing, decoding and playing these newly

emerging formats. For example, to play downloaded content on conventional portable CD players, the downloaded files must be converted from the file system of the personal computer (e.g., FAT16, FAT32, NTFS, etc.) to the CD file system (CDFS) used by CD players and converted to uncompressed Pulse Code Modulation (PCM) encoded data. Then the converted file must be written to a CD to be played. Even more difficult is making audio cassette copies of audio content downloaded from the Internet as most, if not all, personal computers require a user to output the audio content via an audio-out connection provided in a sound card to the user's stereo equipment or cassette recorder.

In view of the above, there is a need for an apparatus that allows listeners to quickly and easily play audio content downloaded to a personal computer over network infrastructures such as the Internet. In particular, there is a need for a portable audio player that allows digital audio data files to played where the digital audio data is organized using common personal computer file systems structures. Further, there is a need for the portable audio device to also function as a portable removable media drive, thus eliminating the need for users to have separate devices for playing downloaded audio content and for reading/writing data to removable media. The present invention provides such a solution.

SUMMARY OF THE INVENTION

In view of the above, the present invention, through one or more of its various aspects and/or embodiments is thus presented to accomplish many advantages, such as those noted below.

In accordance with the present invention, there is provided an audio playback device that includes a removable media drive adapted to receive removable media that contains audio data stored thereon, an audio decoder that decodes the audio data stored on the removable media, an audio Codec which receives the audio data from the audio decoder and decompresses the audio data, a digital to analog converter which receives the audio data from the audio Codec data and outputs analog audio signals, a memory that stores an operating system and a plurality of software Codecs, and a controller that executes the operating system in order to control the receiving and converting of the audio data. The audio playback device is adapted to read a software Codec stored on the removable media associated with the audio data to be decompressed if a suitable Codec to decompress the audio data file is not stored in

the memory. The software Codec may be appended to each audio data file stored on the removable media.

In accordance with a feature of the present invention, the removable media drive comprises a communications interface to communicate the audio data to the controller, and the playback device includes a user interface comprising buttons and a display. The communications interface may comprise a first data bus and the audio playback device may further comprise a second data bus compatible to the first data bus to receive the audio data, and the information to be displayed on the display is displayed utilizing the second data bus. The information takes a second priority to the audio data on the second data bus, and when the second data bus is not in use by the removable media drive, the information is driven onto the second data bus.

The audio playback device further comprises a communications driver, file system logic, and a sound driver, wherein the communications driver receives raw data from the removable media drive, the file system logic interprets the raw data, and the sound driver outputs the audio data to the audio Codec. The raw data may be interpreted as an FAT16 file system, and information such as file name, file size, and a location on the removable media are passed back to the operating system, and wherein the file system logic provides file-level read operations to the audio decoder. Further, a table of clusters comprising the audio data file is determined by the communications driver and optimized into runs of contiguous data clusters.

The audio playback device may also include a random access memory to store a predetermined amount of the audio data as the audio data is transferred from the removable media drive and a second communications interface to communicate data from the portable audio device to external equipment. The audio data files may be organized into playback lists that are provided to the display.

In accordance with another feature of the present invention, the audio playback device may be adapted to operate as a removable data storage device.

In accordance with another aspect of the present invention, there is provided a removable media drive adapted to receive removable media that contains audio data stored thereon. The removable media drive includes an audio decoder that decodes the audio data stored on the removable media, an audio Codec which receives the audio data from the audio

decoder and decompresses the audio data, a digital to analog converter which receives the audio data from the audio Codec data and outputs analog audio signals, and a controller that controls the receiving and converting of the audio data. The removable media drive is adapted to read a software Codec stored on the removable media associated with the audio data to be decompressed if a suitable Codec to decompress the audio data is not stored in a memory of the removable media drive.

In accordance with yet another aspect of the present invention, there is provided a method of playing digital audio data files in a portable audio player having a removable media drive, that includes reading a digital audio file from removable media; determining a suitable Codec to decompress the digital audio, the suitable Codec being selected from a plurality of Codecs stored in a memory; decoding and decompressing the digital audio files in accordance with the suitable Codec; converting the digital audio file to analog audio signals; and outputting the analog audio signals.

In accordance with the method, a predetermined amount of digital audio data may be stored in a memory prior to decoding and decompressing the digital audio data. Also, the suitable Codec may be read from the removable media if no suitable Codec is stored in the memory.

Other features of the invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the preferred embodiments, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings an embodiment that is presently preferred, in which like reference numerals represent similar parts throughout the several views of the drawings, it being understood, however, that the invention is not limited to the specific methods and instrumentalities disclosed. In the drawings:

Fig. 1 is a block diagram of a portable audio player in accordance with the present invention illustrating the components that comprise a removable media player;

Fig. 2 is a block diagram of a portable audio player in accordance with the present invention illustrating the components that comprise audio hardware within the player; and

Fig. 3 illustrates software and interface components that comprise the audio player of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to a portable audio playback system that preferably utilizes well known removable media disks and file systems to store digital audio data. The digital audio data can be loaded onto the disk using a computer having an attached removable media drive. The audio data may come from the user's audio CDs (via a CD-ROM player), line-in to the computer sound card, or downloaded over the Internet. The removable media can then be inserted into the portable audio player of the present invention wherein the audio data is read from the removable media, decoded, decompressed and played-back through headphones for the listener's enjoyment. The present invention preferably is implemented using Iomega® Zip® disks as the removable media and an Iomega® Zip® drive as the removable media drive. It is noted that other types of media, such as optical (e.g., CD and DVD), magneto-optical, and magnetic may be used in conjunction with the appropriate removable media drive, where the audio player is adapted to play the such media. In addition, as will be discussed below, the audio content may be downloaded directly to the portable audio player via a provided communications interface.

Referring to Figs. 1 and 2, there is illustrated a block diagram of the internal elements of the portable audio player 10 that may be generally arranged as audio playback components 20 and a removable media drive 30. As noted, the preferred removable media drive 30 is the Iomega® ZIP® drive, manufactured by Iomega Corporation, Roy, Utah, which has a PHAEDRUS 34 comprising an 8032 microcontroller 35, a 1 kByte RAM 36 and an application specific integrated circuit (ASIC) 37. The ASIC 108 may perform various functions, such as servo sequencing, data splitting, EOC, ENDEC, A-to-D conversion, and D-to-A conversion. The removable media drive 30 may also include disk formatter 33 functions. An IDE interface 31 is provided, which may be used to communicate to a personal computer if the removable media drive is to be connected to the IDE controller of the personal

computer. Similarly, a SCSI or parallel interface may be provided and connected to a SCSI controller or parallel port of the personal computer.

As illustrated in Fig. 2, the audio playback components 20 includes a processor 22, flash memory 23, a Codec 24, RAM 28, and a digital to analog converter 25. The processor preferably comprises a Texas Instruments TMS320C549 or other suitable processor. The audio playback components 20 communicate to the removable media drive 30 via the IDE interface 31. The flash memory/ROM 33 is provided to store a real-time operating system which controls the operation of the portable audio player 10. The Codec 24 receives compressed audio data as Pulse Code Modulation (PCM)data and decompresses the data to output digital audio to the digital to analog converter 25 for conversion to analog audio signals. A predetermined amount of digital audio data may be temporarily stored in RAM 28 after being received from the removable media drive 30 in order to prevent skipping when the portable audio player 10 experiences shock. The analog signals are output over a pair of lines 26 to headphones 50 such that the user can listen to the audio content. Communication between the portable audio player 10 and the personal computer may be accomplished through transfers of data between the input/output channel of the portable audio player 10 via a communications interface 26 to the personal computer (e.g., parallel port, USB port, etc.).

Referring to Fig. 3, there is shown a block diagram of the software components and user interface of the portable audio player 10. As illustrated, the portable audio player 10 includes a user interface 104 comprising buttons 100 and a display 102, a real-time operating system 106, an audio decoder 108, file system logic 110, a communications interface 120, an IDE driver 112, a sound driver 116, and a software Codec 118.

The real-time operating system 106 drives the portable audio player 10 software and other modules within the portable audio player 10. A clock 107 triggers interrupts at regular intervals. Preferably, there are two interrupt frequencies, one for audio decoder updates and another for user interface updates. For example, the user interface 104 may be updated at 172 Hz, while the audio decoder 108 may be called at 44.100 kHz. When receiving an interrupt, the audio decoder interrupt handler copies two words, one for each audio channel which are output to the sound driver 116. The user interface interrupt handler determines the status of the buttons 100 and issues commands to the other modules in accordance with the detected state (e.g., depressed, or not depressed) of the buttons 100.

The portable audio player 10 real-time operating system 106 includes buffering mechanisms. In particular, the portable audio player 10 uses a "Ping-Pong" buffering scheme involving a total of five buffers: two input buffers, two decoder output buffers and a circular buffer used by the serial port hardware. Data is read from a file on the removable media 12 into one of the two input buffers. While the audio decoder 108 decodes from one input buffer, a main control loop reads into the other buffer. The decoding is performed within the audio interrupt period, which is triggered every 6 ms, as noted above. The decoder 108 decodes the data from the input buffer into whichever decoder output buffer is not in use by the serial port. The serial port has a circular buffer from which it sends the decoded audio data to a serial digital-to-analog converter. When the circular buffer is half empty, an interrupt is generated by the serial port hardware which loads more data into the buffer from the decoder output buffer.

The user interface 104 is called on by the portable audio player 10 real-time operating system 106 to determine the status of the buttons 100 provided on the player 10 and to send data to the LCD display 102. The user interface 104 may be divided into two logical parts, the button drivers and the LCD drivers. The button drivers detect the state of the external buttons 100, which may be provided to activate player functions, such as play, reverse, forward, stop, pause, and eject. The LCD driver drives the LCD display 102 in order to provide information to the listener, such as audio track number, elapsed time, remaining time, etc.

In accordance with the present invention, several interfaces are provided through which the portable audio player 10 may acquire audio data to be played. In a preferred embodiment, the audio data may be provided to the player 10 via an IDE Driver 112, which communicates with the removable media drive firmware (e.g., PHAEDRUS 34) to read raw sectors of data from the removable media 12.

The file system logic module 110 is provided to interpret the raw data read by the IDE driver 112. Preferably, the raw data is interpreted as a FAT16 file system. Other file systems may be supported, such as FAT32, NTFS, HPFS, MacOS and CDFS (ISO-9660) file systems. Information such as file name, file size, and the title's location on the disk are extracted and passed back to the real-time operating system 106 on request. The file system logic 110 also provides file-level read operations to the audio decoder 108.

The FAT16 file system is organized such that an audio data file need not be arranged contiguously on the removable media 12. The data file may be split up into sections called clusters. Each cluster is written to whatever space is available on the disk. After several files have been written and erased on a disk 12 without formatting the arrangement of files on the disk can become fragmented. The FAT16 file system provides a table that is effectively a map of all the clusters on the disk. Each entry in the table holds the address of the next cluster in the file that the present cluster is a part of. From this table a list of clusters can be built for each consecutive cluster in the file called a chain.

If the disk 12 becomes too highly fragmented, it may cause the portable audio player 10 to skip while it searches for the next cluster of the file. In order to add a layer of skip protection the chain of clusters is preferably extracted at the beginning of playback of each file on the disk and is buffered in memory 28. Accordingly, this feature of the invention provides a mechanism by which subsequent calls into the file system for data will not cause the system to perform a look up in the FAT16 tables to find the next cluster, while also preventing skipping if the player should be physically jolted. Furthermore, the table of clusters may be optimized into "runs" such that the table that is built consists of two columns. The first column holds the address of the starting cluster of a run, and the second column contains the length in clusters of the run. This way the system can take advantage of less fragmented disks.

The audio decoder 108 is provided to receive and interpret the encoded audio data from the file system logic module 110 in the logical format of the file system logic module 110. Preferably, a Dolby AC3 audio decoding software is utilized, however other decoding methods may be used. The audio decoder 108 receives commands from the real-time operating system 106 such as play, stop, next track and last track as well as a command to copy data from the decoded audio buffer to the sound driver 116.

The sound driver 116 receives the decoded and compressed PCM audio data from the audio decoder 108 and outputs this data to the audio Codec hardware 24 that is programmed with the proper software Codec 118. A Codec (Compressor/Decompressor) is an algorithm or scheme used when recording digital video or audio. For example, when audio or video is transmitted over the Internet, it is often compressed at the transmitting end and,

accordingly, decompressed at the receiving end. The Codec can be chosen based upon the desired audio or image quality and image size preferences.

An IDE bus is used to transfer data to and from the LCD display 102. This transfer of data is performed utilizing a scheme in which the LCD data takes a second priority to the IDE drive data received by the IDE driver 112. When the IDE bus is not in use by the drive 30 the data is driven onto the lower eight lines of the bus and a separate line enables the LCD to latch the data to or from its registers. Thus, the present invention advantageously does not require a separate address decoder or buffers to communicate with the LCD display 102.

In accordance with the present invention, the USB firmware, USB port and parallel port of the portable audio player 10 are preferably implemented in hardware. Thus, the communications interface 120 may be provided to allow the portable audio player 10 to function as a removable media drive 30 (e.g., an external data storage drive) connected to a personal computer via a USB or parallel port. This also allows the portable audio player 10 to download audio data directly from a personal computer. Accordingly, the portable audio player 10 could be used as conventional Zip® drive. Such a configuration would prove to be a great bonus to consumers who desire both a portable audio device and external high capacity removable media drive.

As noted above, one of the limitations of conventional portable audio devices is that they can only recognize one audio format. For example, CD players read simple uncompressed PCM encoded audio from CDs, and the Diamond Multimedia Rio player only reads files compressed using the MP3 audio format. However, the portable audio player 10 of the present invention advantageously enables consumers to configure the portable audio player 10 to decode and decompress any audio format. Because the Codec for most audio formats is roughly 20 to 50 kB, a plurality of Codecs may be stored in flash memory 23, or the real time operating system 106 may read the Codec 118 from the disk 12 into flash memory 23 to "learn" the audio format of the audio file to be decompressed if the proper Codec is not presently in flash memory 23. For example, the decompressing Codec 118 may be appended to each audio data file and the real-time operating system 106 may determine if the proper Codec to decompress the digital audio data is stored in flash memory 23. If not, the Codec is read from the disk 12. This is possible because the size of the Codecs 118 are

relatively insignificant as compared to the size of the audio data files, which may range from 1 MB per minute for highly compressed formats such as MP3 or AC3 to 10 MB per minute for uncompressed PCM encoded audio streams. Using this approach makes the audio data and the algorithm to decompress it immediately available to portable audio player 10.

As users put many files on removable media for playback on their portable audio device, they may want to group these tiles by artist or album and have the portable audio player 10 play-back only the files in that group. This can easily be accommodated by the FAT16 file system, as these groups may be simply placed in subdirectories on the disk and listed in play list tiles displayed to the user on the LCD display 102 in accordance with their location in a particular subdirectory. This grouping ability would make the system similar to a CD changer, i.e., several logical discs may reside on one physical disk.

It is noted that the foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention. While the invention has been described with reference to preferred embodiments, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitations. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein: rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

WHAT IS CLAIMED IS:

1. An audio playback device, comprising:

a removable media drive adapted to receive removable media that contains audio data stored thereon;

an audio decoder that decodes said audio data stored on said removable media;

an audio Codec which receives the audio data from said audio decoder and decompresses the audio data;

a digital to analog converter which receives the audio data from said audio Codec data and outputs analog audio signals;

a memory that stores an operating system and a plurality of software Codecs; and

a controller that executes said operating system in order to control the receiving and converting of the audio data,

wherein said audio playback device is adapted to read a software Codec stored on said removable media associated with the audio data to be decompressed if a suitable Codec to decompress the audio data file is not stored in said memory.

2. The audio playback device as recited in claim 1, wherein said removable media drive comprises a communications interface to communicate the audio data to said controller, and said playback device includes a user interface comprising buttons and a display.

3. The audio playback device as recited in claim 2, wherein said communications interface comprises a first data bus and said audio playback device further comprises a second data bus compatible to said first data bus to receive the audio data, and wherein information to be displayed on said display is displayed utilizing said second data bus.

4. The audio playback device as recited in claim 3, wherein said information takes a second priority to the audio data on said second data bus, and when said second data

bus is not in use by said removable media drive, said information is driven onto said second data bus.

5. The audio playback device as recited in claim 2, wherein said audio playback device further comprises a communications driver, file system logic, and a sound driver, wherein said communications driver receives raw data from said removable media drive, said file system logic interprets said raw data, and said sound driver outputs the audio data to said audio Codec.

6. The audio playback device as recited in claim 5, further comprising a clock, wherein said clock triggers interrupts at regular intervals for updating said audio decoder and said user interface.

7. The audio playback device as recited in claim 6, wherein intervals of updates to said user interface and said audio decoder are different, and said communications driver comprises an IDE driver.

8. The audio playback device as recited in claim 7, wherein an audio decoder interrupt handler copies two words, one for each audio channel which is output to said sound driver, and a user interface interrupt handler determines the status of said buttons and issues commands in accordance with the status to said operating system.

9. The audio playback device as recited in claim 5, wherein said raw data is interpreted as a FAT16 file system, and information such as file name, file size, and a location on said removable media are passed back to said operating system, and wherein said file system logic provides file-level read operations to said audio decoder.

10. The audio playback device as recited in claim 9, wherein a table of clusters comprising the audio data file is determined by said communications driver and optimized into runs of contiguous data clusters.

11. The audio playback device as recited in claim 2, wherein said operating system includes buffering mechanisms.

12. The audio playback device as recited in claim 2, further comprising random access memory to store predetermined amount of the audio data as the audio data is transferred from said removable media drive.

13. The audio playback device as recited in claim 2, further comprising a second communications interface to communicate data from said portable audio device to external equipment.

14. The audio playback device as recited in claim 13, wherein said audio playback device is adapted to operate as a removable data storage device.

15. The audio playback device as recited in claim 2, wherein the audio data files are organized into playback lists, and wherein said playback lists are provided to said display.

16. The audio playback device as recited in claim 1, wherein said software Codec is appended to each audio data file stored on said removable media.

17. A removable media drive adapted to receive removable media that contains audio data stored thereon, comprising:

an audio decoder that decodes said audio data stored on said removable media;

an audio Codec which receives the audio data from said audio decoder and decompresses the audio data;

a digital to analog converter which receives the audio data from said audio Codec data and outputs analog audio signals; and

a controller that controls the receiving and converting of the audio data,

wherein said removable media drive is adapted to read a software Codec stored on said removable media associated with the audio data to be decompressed if a suitable

Codec to decompress the audio data file is not stored in a memory of said removable media drive.

18. The removable media drive as recited in claim 17, wherein said removable media drive comprises communications interface to communicate the audio data to said controller, and said playback device includes a user interface comprising buttons and a display.

19 The removable media drive as recited in claim 18, wherein said communications interface comprises an IDE bus, and wherein information to be displayed on said display is displayed utilizing said IDE bus.

20. The removable media drive as recited in claim 19, wherein said information takes a second priority to the audio data on said IDE bus, and when said IDE bus is not in use by said removable media drive, said information is driven onto said IDE bus.

21. The removable media drive as recited in claim 18, and said removable media drive further comprises a communications driver, file system logic, and a sound driver, wherein said communications driver receives raw data from said removable media drive, said file system logic interprets said raw data, and said sound driver outputs the audio data to said audio Codec.

22. The removable media drive as recited in claim 21, wherein raw data read from said removable media drive is interpreted as a FAT16 file system, and information such as file name, file size, and a location on said removable media are passed back to said operating system, and wherein said file system logic provides file-level read operations to said audio decoder.

23. The removable media drive as recited in claim 18, further comprising random access memory to store a predetermined amount of the audio data as the audio data is transferred from said removable media drive.

24. The removable media drive as recited in claim 18, further comprising a second communications interface to communicate data from said portable audio device to external equipment.

25. The removable media drive as recited in claim 17, wherein said software Codec is appended to each audio data file stored on said removable media.

26. A method of playing digital audio data files in a portable audio player having a removable media drive, comprising:

reading a digital audio file from removable media;

determining a suitable Codec to decompress said digital audio, said suitable Codec being selected from a plurality of Codecs stored in a memory;

decoding and decompressing the digital audio files in accordance with said suitable Codec;

converting the digital audio file to analog audio signals; and

outputting said analog audio signals.

27. The method of playing digital audio data files as recited in claim 26, further comprising storing a predetermined amount of digital audio data in a memory prior to decoding and decompressing the digital audio data.

28. The method of playing digital audio data files in a portable audio player as recited in claim 26, further comprising reading said suitable Codec from said removable media if no suitable Codec is stored in said memory.

29. The audio playback device recited in claim 1 wherein said memory is a read-only memory.

30. The audio playback device recited in claim 29 wherein said read-only memory is a flash card memory.

FIG. 1

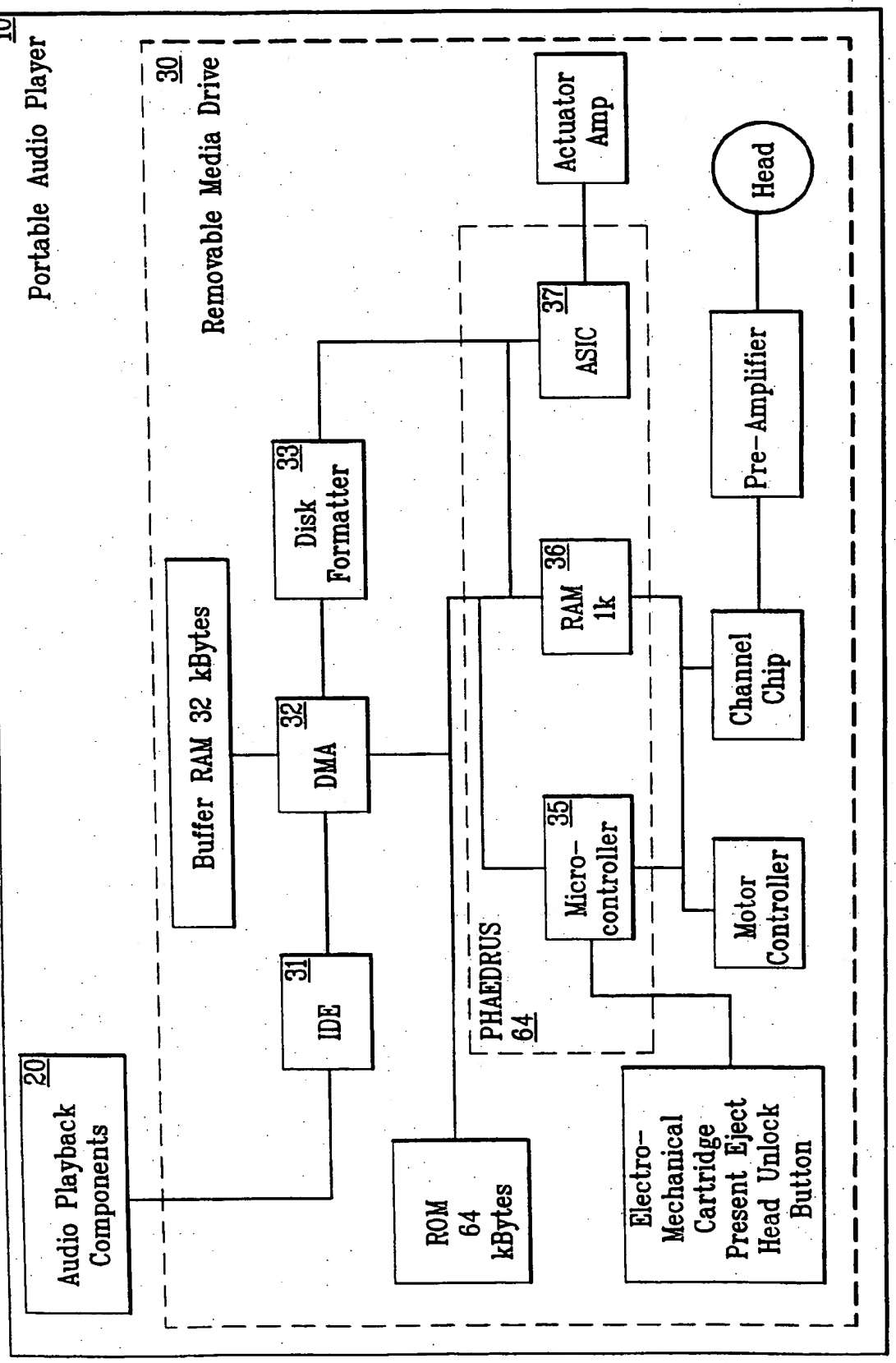

10
Portable Audio Player
30
Removable Media Drive
Actuator Amp
Head
37
ASIC
Pre-Amplifier
33
Disk Formatter
36
RAM 1k
Buffer RAM 32 kBytes
32
DMA
Channel Chip
35
Micro-controller
Motor Controller
PHAEDRUS
64
31
IDE
20
Audio Playback Components
ROM 64 kBytes
Electro-Mechanical Cartridge Present Eject Head Unlock Button

FIG. 2

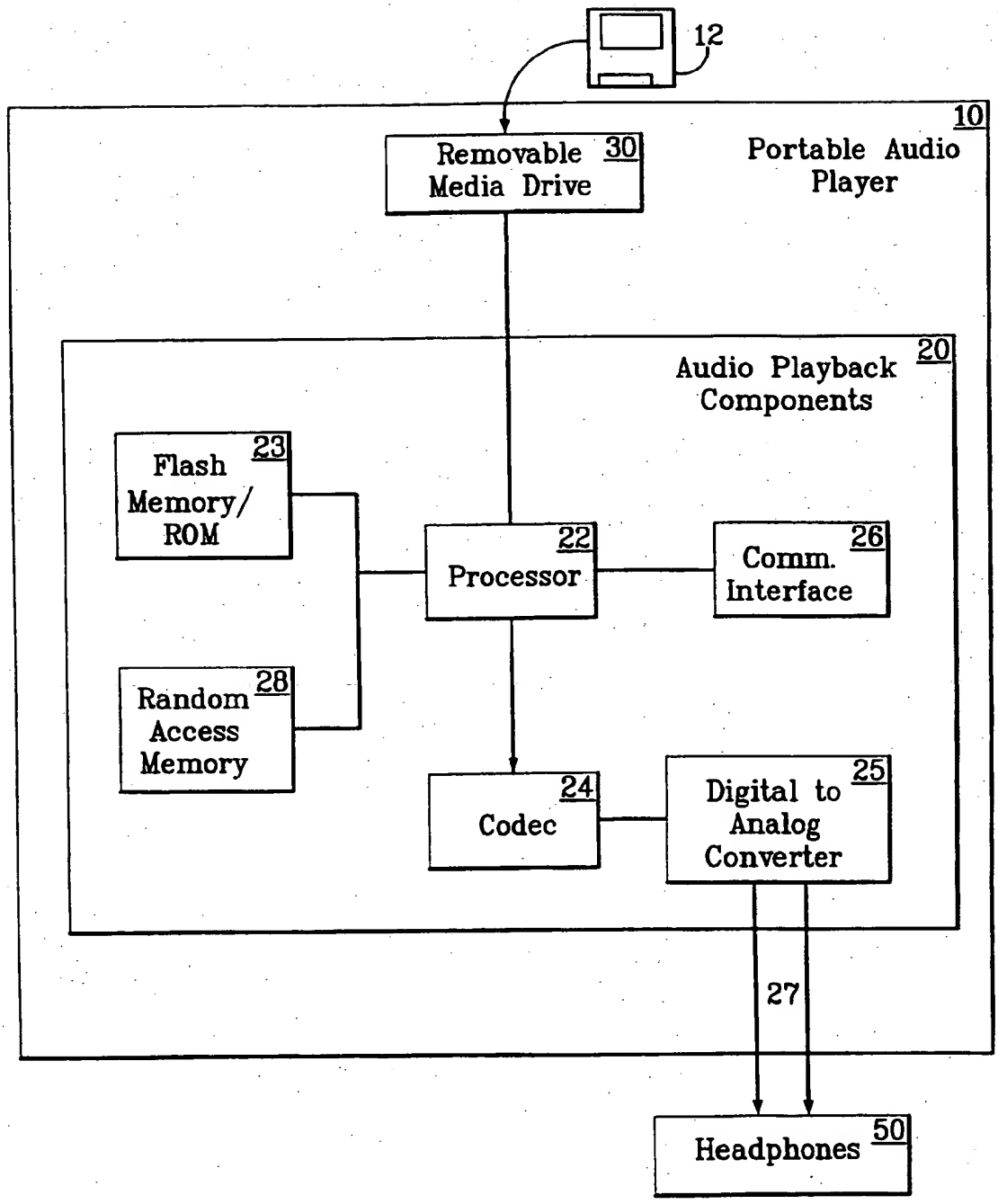
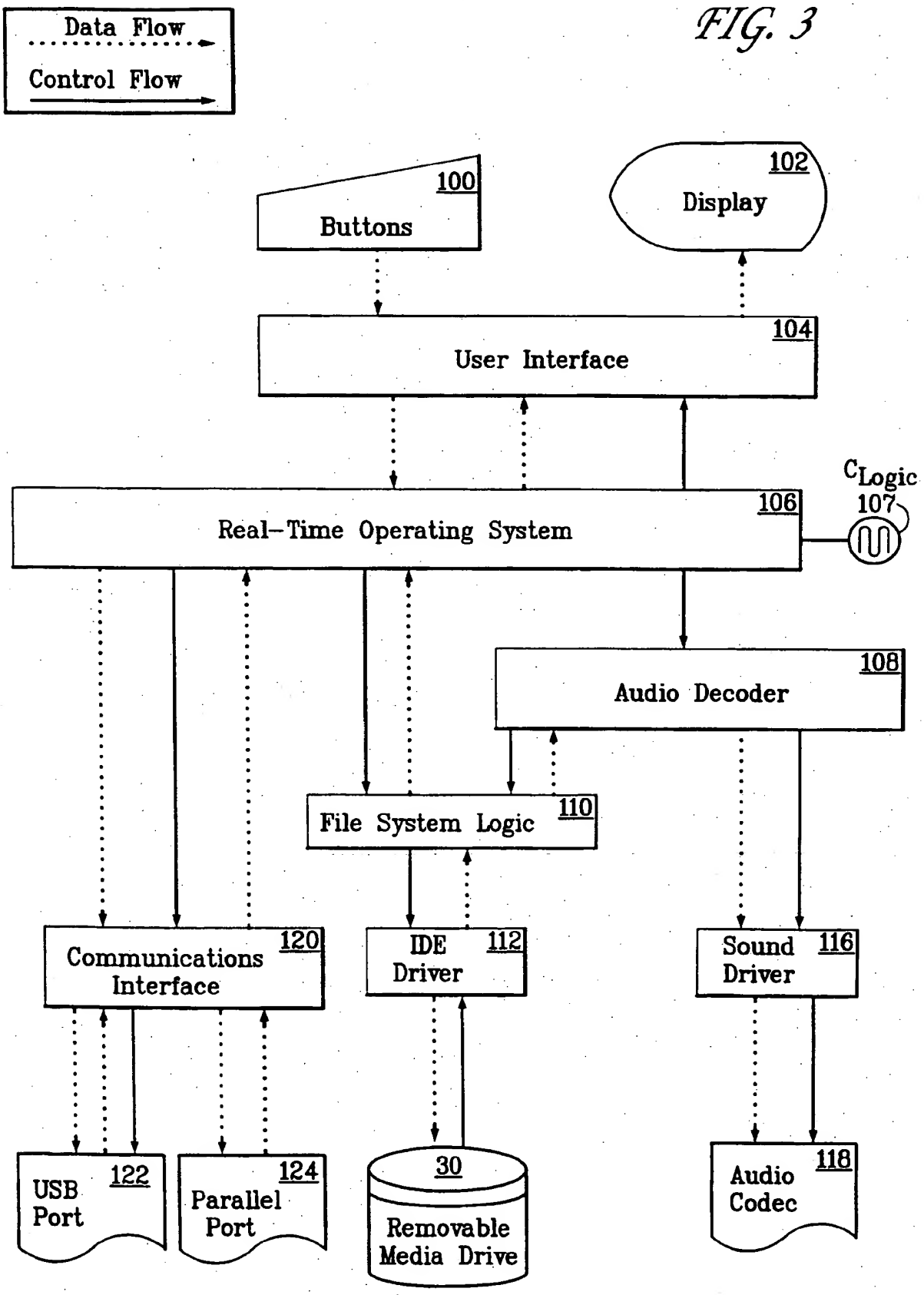

12
10
Removable Media Drive 30
Portable Audio Player
20
Audio Playback Components
Flash Memory/ ROM 23
Processor 22
Comm. Interface 26
Random Access Memory 28
Codec 24
Digital to Analog Converter 25
27
Headphones 50

FIG. 3


Data Flow
Control Flow
100
Buttons
102
Display
104
User Interface
106
Real-Time Operating System
C Logic
107
108
Audio Decoder
110
File System Logic
120
Communications Interface
112
IDE Driver
116
Sound Driver
122
USB Port
124
Parallel Port
30
Removable Media Drive
118
Audio Codec

INTERNATIONAL SEARCH REPORT

Int. :ional Application No
PCT/US 00/28847

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B20/10 G11B20/00 G10H1/36 G10H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B G10H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	US 6 061 306 A (BUCHHEIM JAMES) 9 May 2000 (2000-05-09) the whole document	1,11-15, 17,23, 24,26-30
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 February 2001	06/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schiwy-Rausch, G

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